susceptible of exact measurement, but, as stated above, the readings of the wet bulb thermometer are considered the best measure available of the temperature actually felt by the human body.

It is very interesting to compare climatic conditions in Panama with conditions in various sections of the United States on this basis. Average daily maximum shade temperatures and the computed maximum daily sensible temperatures (wet bulb) for the month of July are presented in the following table:

Stations.	Actual average daily maximum temperature for July.	Computed average maximum sensible temperatures for July (wet bulb).
	°F.	°F.
Balboa Heights, C. Z	87	79
Cristobal, C. Z	84	78.5
Mobile	90	77.7
New Orleans	89	77
St. Louis	87	73
Phœnix	104	72
Kansas City	86	72
New York	82	70
Chicago	80	69
El Paso	94	68
Fresno	100	66
Denver	86	64
San Francisco	64	57

It should be noted that maximum *shade* temperatures only are used in the above table. No attempt is made to estimate the superheating effects of the sun on bodies exposed to direct solar radiation.

It will be seen that the *average* daily maximum July temperatures are much higher in many sections of the United States than in Panama, but the maximum *sensible* temperatures are higher in Panama than anywhere in the United States, due to the prevailing high humidity. Midsummer conditions of temperatures and humidity in the Gulf States more closely approach the conditions that prevail in Panama.

Dry season sensible temperatures in Panama are about 3° F. lower than those of the rainy season, due to the lower humidity and higher wind movement that prevails in the dry season. This explains the less oppressive character of our dry-season weather.

The high sensible temperatures and hot, humid atmospheric conditions that prevail in Panama would seem to be productive of frequent cases of sunstroke and heat exhaustion, but such is *not* the case. Canal Zone vital statistics covering the past 13 years show but two deaths from sunstroke, one in Panama and one in Colon. The total number of cases of heat exhaustion reported among the entire population of about 120,000 during this 13-year period was only 21, and none of these cases proved fatal.

While deaths from overheating are extremely rare in Panama, it is undoubtedly true that the habitual lassitude and inefficiency of tropical labor is due in large measure to the prevailing conditions of temperature and humidity.

Sufficient data are not available upon which to base an exhaustive study of this subject, but it is thought that, in general, cases of sunstroke and heat exhaustion are relatively rare both in *extremely humid* hot climates and in *arid* hot climates. It is in the *moderately humid* warm climates, such as prevail in central and eastern sections of the United States, that cases of sunstroke and heat exhaustion are most prevalent. Such cases seem to occur more frequently in large cities, probably being aggravated by the excessive radiation of heat from street paving, sidewalks, and masonry walls, and also by the lack of free air circulation in congested districts. Undernourishment and low vitality of the patients may be contributory causes.

Conditions of humidity powerfully affect plant life also. The blighting effects of the withering hot winds of Kansas that carry damage or destruction to growing crops are due more to *moisture deficit* than to *high temperatures*.

The needs of animal and plant life differ, and, generally speaking, the conditions of heat and humidity most favorable for luxuriant plant growth (warm and humid) are relatively unfavorable for human health and comfort.

The average maximum temperature records and the corresponding wet-bulb readings at stations in the United States used in the accompanying table were taken from a Weather Bureau report on "Relative Humidities and Vapor Pressures over the United States" by Mr. Preston C. Day, published as MONTHLY WEATHER REVIEW SUPPLEMENT No. 6. Wet-bulb temperatures corresponding to the daily maximum temperatures were computed from the daily maximum temperatures and the relative humidity.

COMFORTABLE TEMPERATURES.

By W. KÖPPEN.

[Abstracted from *Das Wetter*, July-August, 1918, pp. 116-117.]

The temperatures at which the greatest comfort is felt are those in the neighborhood of 18° C. Out of doors, temperatures are considered comfortable when they lie between 14 and 18° C. at night, and between 18 and 22° in the daytime. A person who would live the year around in such temperatures, however, would have to travel so much if he remains at sea-level, that he would have little time in a given locality to establish a home.

In the northern hemisphere in the vicinity of Europe, he would gradually move north from Cairo in January, February, and March; in April he would be in Seville; in May he would go northward to Greece or Italy; in July to London, Christiania, and Helsingfors; and through the second half of the year he would retrace his journey. In the East, he would find himself in January in Calcutta, in March in Hongkong, in May in Peking and Tokyo, and thence up the coast.

Such traveling as this, however, is not practical and the person who would seek to maintain a comfortable temperature throughout the year must do it by means of ascending and descending the mountains of his vicinity.—*C. L. M.*

OPTIMUM TEMPERATURE FOR HUMAN ENERGY.

By ELLSWORTH HUNTINGTON.

[Abstract translated from *La Nature Supplement*, Mar. 22, 1919.]

Prof. Ellsworth Huntington has published in the *Proceedings of the National Academy of Sciences* a study of this subject based on statistics.

1. If the temperature of the seasons in which the death rate is lowest is noted, it is found, in the cities of the United States as well as in those of Europe and Asia, a minimum in the springtime and in the autumn, when the mean daily temperature is in the neighborhood of 18° C.

2. If the maximum of work obtained from laborers in various factories extending from Connecticut to Florida is investigated, it is found that this maximum is obtained where the temperature oscillates about 17° C.

3. Finally, if, with a dynamometer, the muscular force of workers is measured during several seasons, it is found that the maximum efficiency occurs with a temperature of 16 to 19° C.

From these widely diverse sources of information, it appears that the optimum temperature for the human being is in the neighborhood of 18° C.

NOTE ON DR. GRIFFITH TAYLOR'S CLIMOGRAPH CHARTS.

A note from Dr. Griffith Taylor, of Melbourne, Australia, calls attention to an unintended implication in a sentence in an abstract of a note by Sir Napier Shaw on "Climograph Charts," (MO. WEATHER REV., July, 1919, p. 494), calling attention to use of the essential principle of the climograph by Dr. John Ball before Dr. Taylor's use of it. The sentence referred to which states that this "is a fact that should be noted," was not intended to discredit Dr. Taylor's independent invention of the climograph. In fact, there is no copy of Dr. Ball's article in the Royal Society's or any of the other large libraries in Victoria. Moreover, Dr. Taylor's climograph has wet-bulb temperatures plotted against humidity, which seems to give a better climograph than Dr. Ball's dry-bulb temperatures plotted against humidity.

EFFECT OF HIGH TEMPERATURE, HUMIDITY, AND WIND ON THE HUMAN BODY.[1]

By C. W. B. NORMAND.

[Reprinted from Science Abstracts, Apr. 30, 1920, Sect. A, §521.]

Under climatic conditions such that air temperature is above blood heat the gain of heat to the human body through convection may exceed the maximum cooling power derived from perspiration. As the rate of gain of heat through convection increases with wind velocity, while the rate of perspiring has a definite limit, it follows that, under given conditions of relative humidity, to each air temperature above blood heat there must, theoretically at least, correspond a certain critical value of wind velocity which, if exceeded, will produce a net gain of heat to the body. Under these conditions it is assumed that continued existence becomes impossible. The greater the air temperature the lower this critical wind velocity becomes.

The human body may be regarded as somewhat similar in action to a wet-bulb thermometer, which maintains its temperature by a balance between convection and evaporation. In the paper a curve is worked out by means of the wet-bulb formula, showing the conditions of air temperature and relative humidity under which a wet-bulb thermometer at blood temperature neither gains nor loses heat in a given wind velocity. Under all conditions of temperature and humidity which represent points on the diagram on one side of the curve there will be a net gain of heat, and under conditions representing points on the other side a net loss. The human body can not supply perspiration at more than a certain rate, which is analogous to a wet-bulb thermometer having a definite fixed maximum rate of supply of water. The modification in the above curve introduced by this condition is investigated. By this means the conditions of temperature, relative humidity and wind under which human life is possible are indicated with such accuracy as our present knowledge of the different conditions involved allows. As an example, with temperature at 122° F. and humidity at 8 per cent, life becomes impossible with a wind velocity above 15 meter-seconds. The fatal simoon may be explained by this means.—*J. S. Dines.*

[1] *Roy. Met'l Soc. Quart. Jour.*, Jan., 1920, 46: 1–11; discussion, 12–14.

THE EXTENSION OF KATA-THERMOMETER OBSERVATIONS.

[Reprinted from Meteorological Office Circular, Mar. 1, 1919, pp. 3–4.]

Dr. Leonard Hill, F. R. S., Central Staff Medical Research Committee, the inventor of the kata-thermometer, is anxious for its use to become general. The advantage of this instrument is that the readings show the combined effect of wind, temperature, sunshine, and humidity in a way comparable to the experience of the human body. The kata-thermometer is simply an ordinary thermometer of known dimensions which has to be warmed to 100°, so that the time of cooling from 100° to 95° may be observed. It is suggested that the merits of, say, Skegness and Torquay as health resorts for people of different types could be compared more satisfactorily by kata-thermometer readings than by any other observations. From the official point of view the observations are subject to the defect that the records depend so largely on exposure; in fact, they provide a measure of exposure, formulæ for estimating the speed of the wind in the immediate neighborhood from the comparison of kata-thermometer readings with the air temperature and humidity having been developed. Accordingly in publishing results it would not suffice to indicate Skegness and Torquay as the meteorological stations; the localities, sea front, inclosed garden, or what not would have to be specified. Two or three stations would really be desirable in a single health resort. It may be possible, however, to make suitable arrangements for publication if the observations become general. * * *

It should be mentioned that Dr. Hill is also asking for measurements of the temperature reached by black bodies exposed to the wind as well as to the sun or sky shine. For this purpose he uses a piece of black fur, the temperature of which is ascertained by stroking it with a small-bulbed thermometer until steady readings are obtained.

THE IMPORTANCE OF AIR CONTROL IN HOSPITALS.

The Modern Hospital, for April and May, 1920 (vol. 14, pp. 271–275; 348–353), contains two articles of timely interest by Prof. Ellsworth Huntington, of Yale, dealing with the control of air in hospitals and other public buildings. The first installment treats especially of the purpose of controlling the air, and the second chiefly of the methods employed to control the air and the results that have been attained. One of the outstanding points mentioned by Prof. Huntington is the importance of small variations in the temperature, humidity, and movement of the air, in their effect upon human life.

The most important atmospheric factors are temperature, humidity, purity, movement, and variability. In most ventilating systems, however, the most attention is paid to the question of temperature and that usually to the end of producing constant temperature. The importance of humidity is recognized, also, but it is only a perfunctory recognition and, as a rule, the steps taken to control the humidity are entirely inadequate. Purity is easily controlled, partly because nature is constantly striving to produce pure air, and partly because artificial contamination by dust is easily prevented. Movement and variability are often neglected because they are frequently construed to mean drafts and hence colds. But experiment has proved that, with all other conditions the same, the patient who spends his time where the air can move over him in variable gusts with consequent short-period variations of temperature stands better chance of